Integration Capacity Analysis Workshop 11/10/15

California IOU's Approach

Background and Importance of ICA

Definition: analysis will specify how much DER hosting capacity may be available on the distribution network down to the line section or node level with no significant upgrades. The DER is to be evaluated on its impact to:

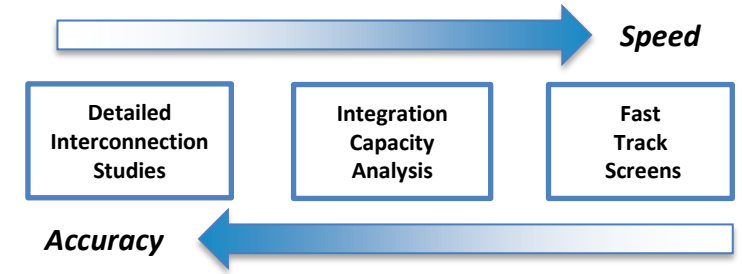
- Equipment Thermal Ratings,
- Protection Limits,
- Power Quality and Voltage,
- Safety Standards

Importance: DER growth rates are rapidly increasing. ICA will enable a more proactive and efficient analysis to ensure timely interconnections along with a safe and reliable grid.

Goals: To inform "Optimal Location" for DERs in conjunction with "Locational Benefits Analysis". The analysis will also seek to improve the efficiency of the grid interconnection process through coordination between this work product and each Utility's Rule 21 interconnection, Rule 15 main extensions, and Rule 16 service connection study processes.

Common Methodology: Utilities performed a common methodology where as advanced power flow tools were utilized by analyzing thresholds across the four major power system criteria. Results are obtained at the line section level and reported and published on online maps.

New Tools and Techniques: IOUs were instructed to develop a new methodology at the same time the research community and software developers are experimenting with tools and techniques in calculating Integration Capacity. Much coordination is needed with research community and software developers to ensure methods and tools are consistent in the industry for this new methodology.



PG&E SDGE SOUTHERN CALIFORNIA EDISON

cyme INTERNATIONAL T&D IA INTEGRAL ANALYTICS LOADSEER

EPRI ELECTRIC POWER RESEARCH INSTITUTE DNV·GL

SYNERGI™ ELECTRIC

Tools and Data Required

Integration and Scalability: This is important with 1,000's of distribution circuits being analyzed by the tools. Processes need to be automated, systems integrated, and hardware scaled to perform analysis consistently and on a regular basis.

Tools Used in Analysis

- Power Flow (Circuit Modeling)
  - *CYMDIST* (PG&E/SCE)
  - *SYNERGI* (SDG&E)
- Batch Processing
  - *Python in CYME* (PG&E/SCE)
  - *SYNEGI Solver* (SDG&E)

CYME INTERNATIONAL T&D

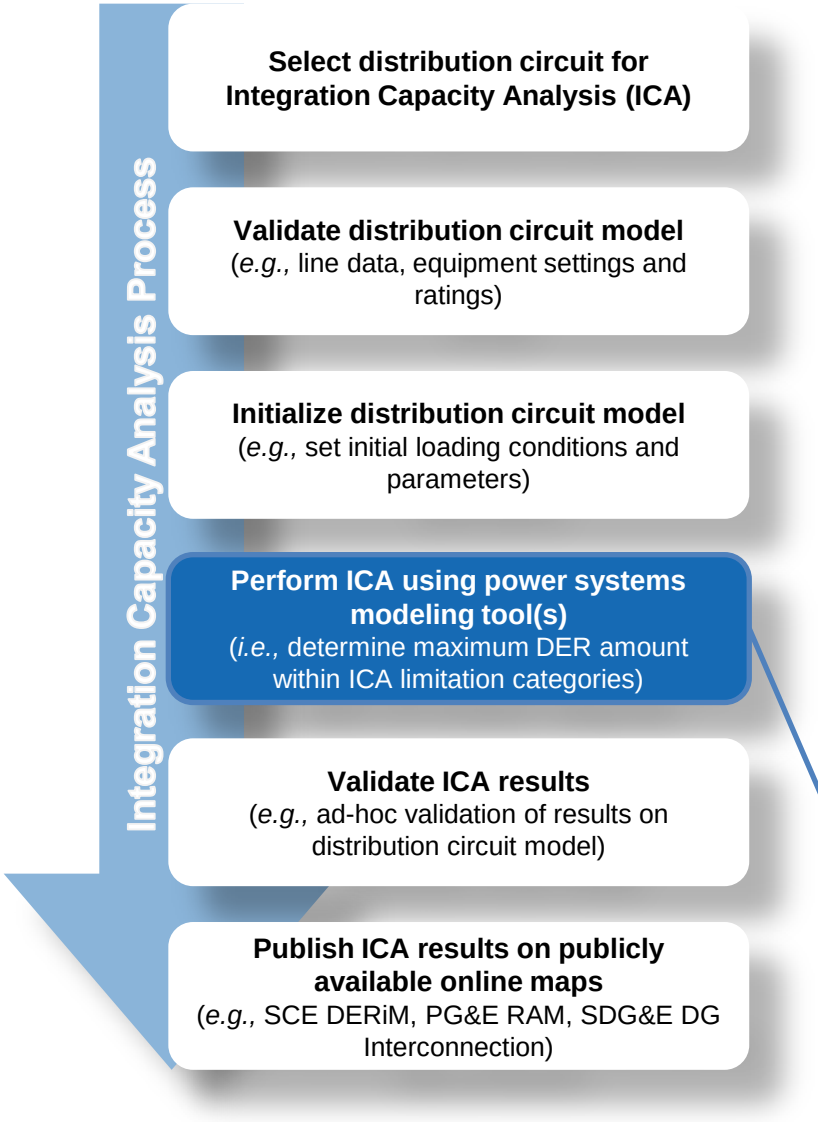
python™

SYNERGI™ ELECTRIC

Datasets

- Comprehensive Electric Circuit Model
  - *Connectivity Model* - Topology/Node-to-Node model
  - *Asset Data* - Nameplates and Equipment Ratings
  - *Planning Data* - Loading
  - *Operating Data* – Settings
  - *Electrical Characteristics* – Impedance and Fault Duties
- Load and Generation Hourly Profiles
  - Utilize hourly SCADA and load profile information
- Distribution Operating Rules
  - Analyze based on operating rules to ensure operator, lineman, and public safety is considered

Implementation Detail of Methodology and Calculations

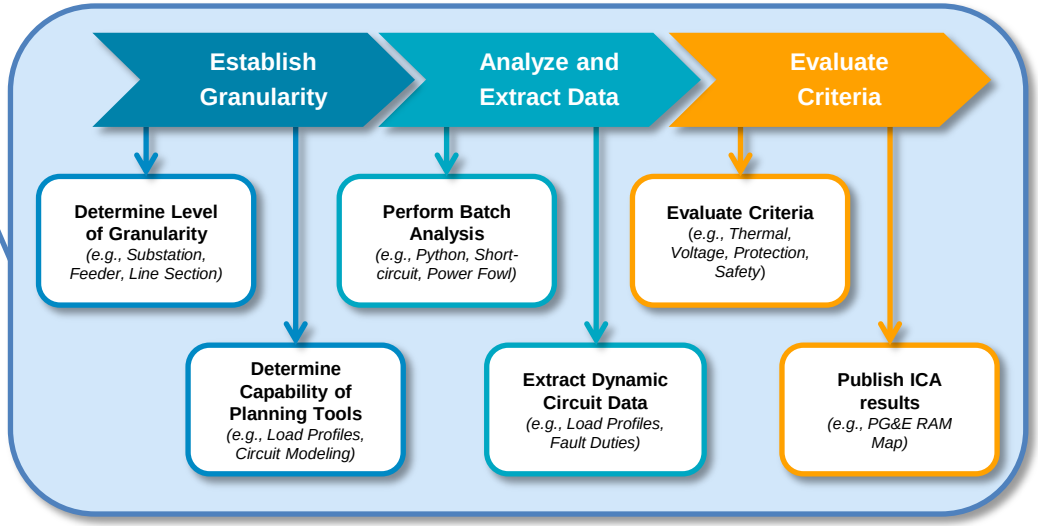


Circuit Granularity

- IOUs perform node level calculations within the circuit
- Establish line sections (differences subject to utility dataset of circuit topology and connectivity)
  - *SCE / SDG&E* : Segments determined by impedance
  - *PG&E*: Line Device

Time Periods Analyzed

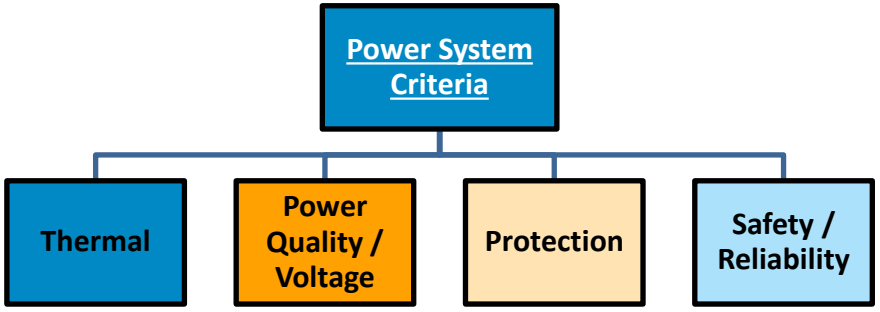
- Hourly profiles needed to determine the impact of the DER throughout the day
  - SCE/SDG&E: Peak and daytime minimum load times
  - PG&E: 24 hour period for each of the 12 months

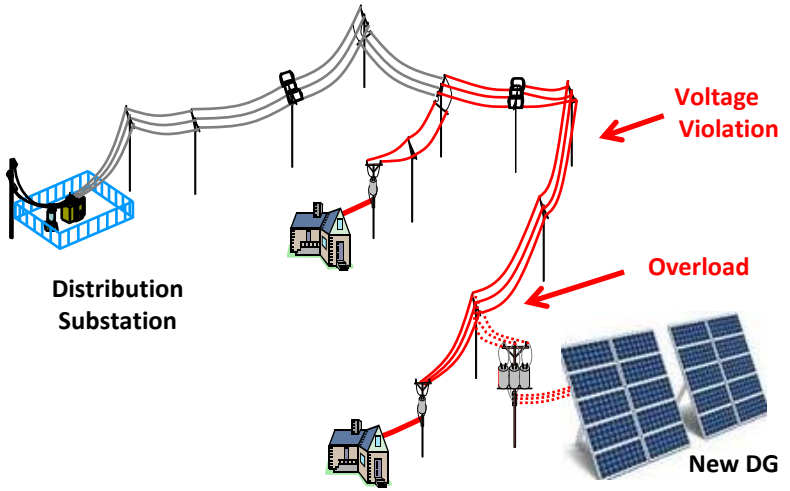


Implementation Detail of Methodology and Calculations (cont.)

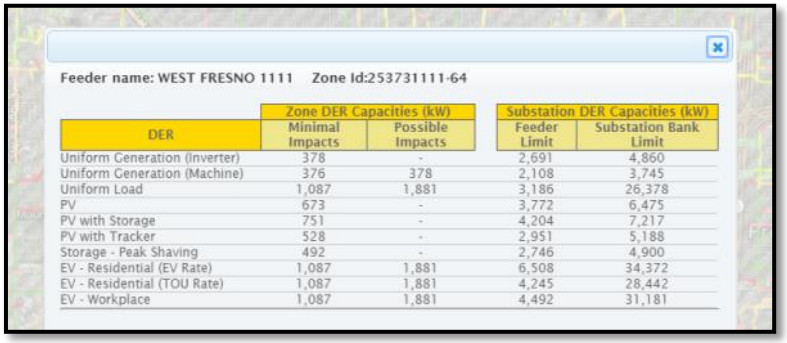
Criteria Assessed

- IOUs looked to include similar components as EPRI streamlined methodology
- At least one component from each major criteria was used in the analysis
- IOUs recognize future enhancements are needed to ensure analysis of other criteria recognized
  - (i.e. Transmission issues and harmonic resonance)
- Dynamic time-series analysis may address some components
- Assessment of transmission impacts requires separate tools and analysis
- Tools allowed for analysis of criteria limits and impacts rather than general screening
- More research is needed to properly analyze abnormal configurations and operational flexibility





Results of Integration Capacity Analysis


Feeder name: WEST FRESNO 1111 Zone Id:253731111-64

DER	Zone DER Capacities (kW)		Substation DER Capacities (kW)	
	Minimal Impacts	Possible Impacts	Feeder Limit	Substation Bank Limit
Uniform Generation (Inverter)	378	-	2,691	4,860
Uniform Generation (Machine)	376	378	2,108	3,745
Uniform Load	1,087	1,881	3,186	26,378
PV	673	-	3,772	6,475
PV with Storage	751	-	4,204	7,217
PV with Tracker	528	-	2,951	5,188
Storage - Peak Shaving	492	-	2,746	4,900
EV - Residential (EV Rate)	1,087	1,881	6,508	34,372
EV - Residential (TOU Rate)	1,087	1,881	4,245	28,442
EV - Workplace	1,087	1,881	4,492	31,181

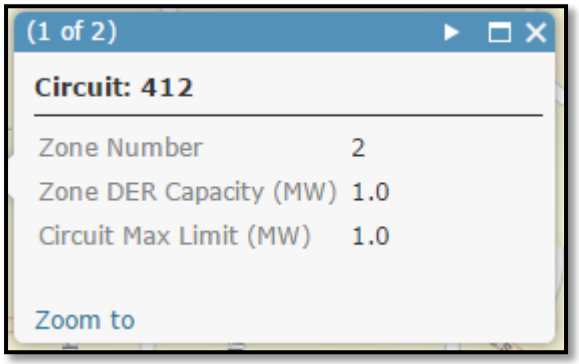
PG&E Map Pop Up Box

Current Status

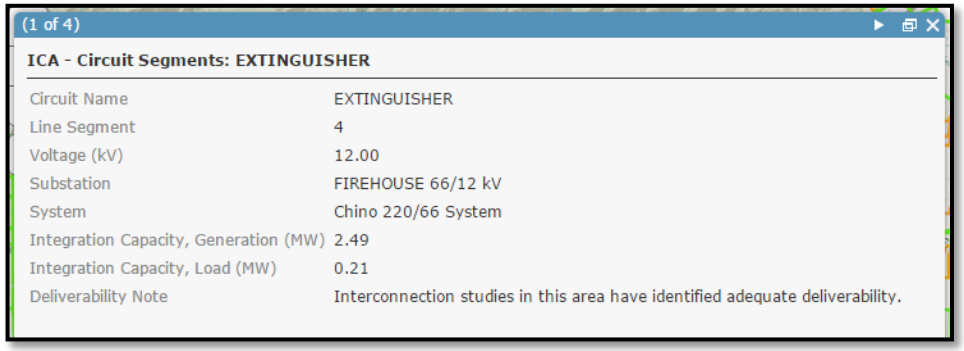
- As part of the 2015 DRP, all IOUs published an Integration Capacity down to the line segment for all of their distribution circuits based on initial implementation of methodology
- Results are published for each line section analyzed on each IOU's RAM map
  - SCE: Load and Generation Limits
  - SDG&E: Generation Limit
  - PG&E: Load, Generation, and DER Scenario Limits

Future Enhancements

- Inclusion of other criteria such as transmission limitations
- Datasets and electrical models are being improved
- Integrating planning tools and creating efficient analysis processes

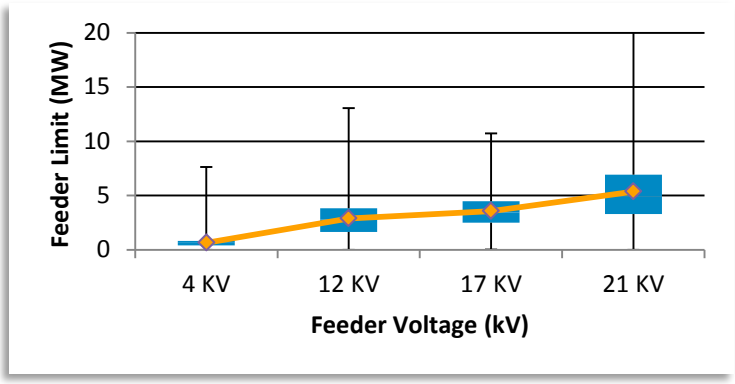


SDG&E Map Pop Up Box

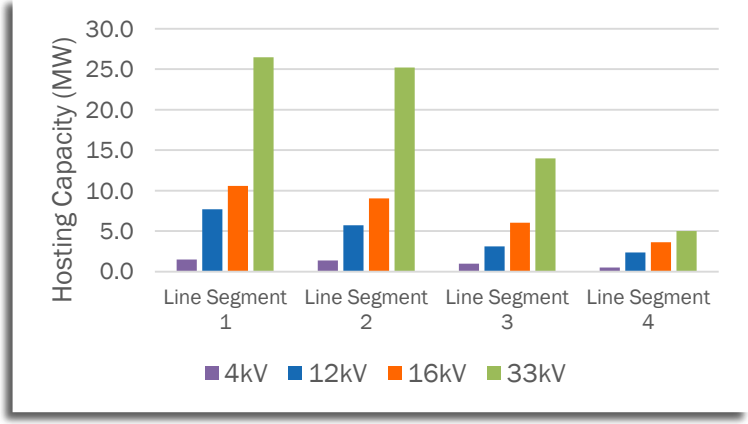


SCE Map Pop Up Box

Results of Integration Capacity Analysis (cont.)



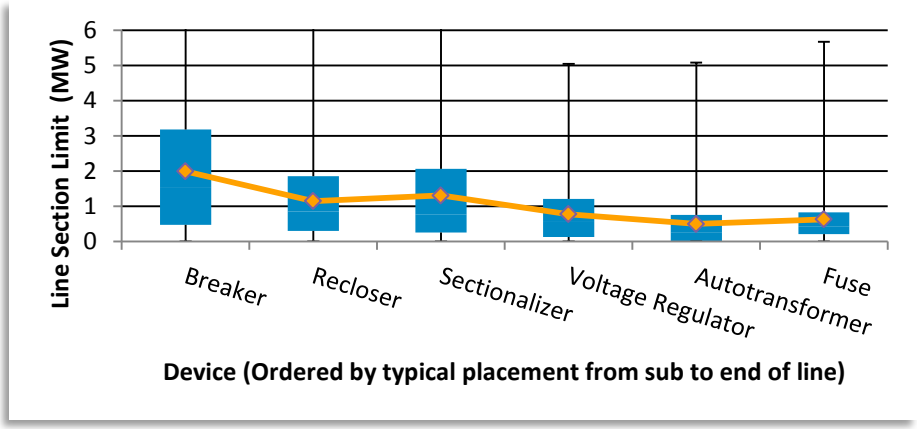
PG&E– Range of PV Hosting Capacity across all Circuits by Voltage Class



SCE– Average Producing Hosting Capacity for the 30 Representative Circuits by Voltage Class

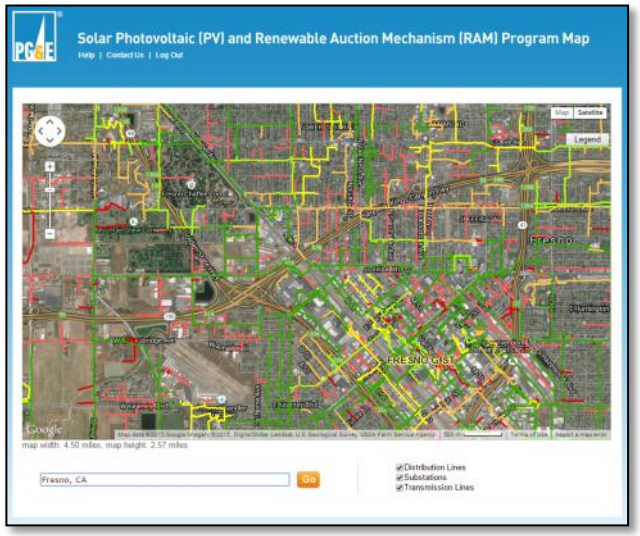
Key Findings

- **Resistance/Impedance** from the source substation highly influences the integration capacity across a feeder
  - Roughly correlated to distance from substation, but specific conductor sizes used for different circuit routes can vary in resistance for similar distances
- Higher the **operating voltages** yield higher Integration Capacity
  - Generally, 4kV circuits have the lowest Integration Capacity values
- The higher the **minimum loading**, the higher the Integration Capacity of a circuit
  - i.e. More PV can be hosted on feeders with daytime peaks where the daytime minimum load is higher



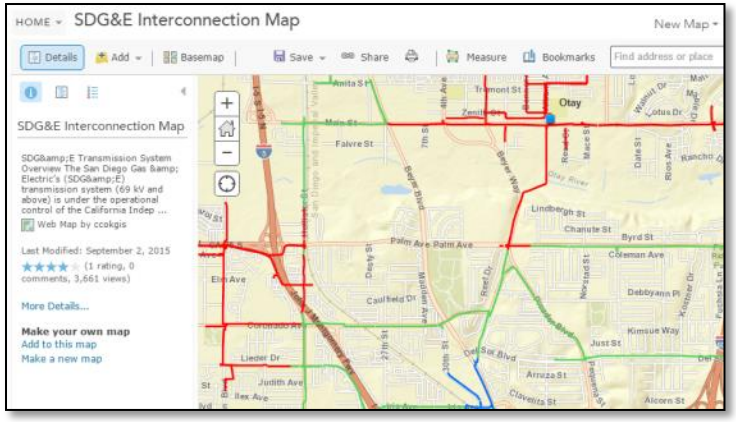
PG&E– Range of PV Hosting Capacity across all Circuits by Line Device

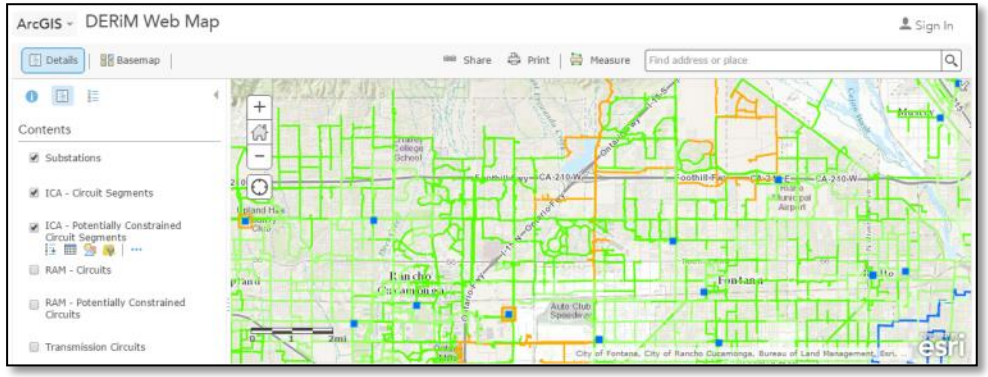
Results of Integration Capacity Analysis (cont.)



Update Process

- Batch processing and data conditioning must be performed in order to analyze up to date circuit conditions
- Desired goal of IOUs is to have maps updated monthly
- Fast growing/high penetration areas warrant most frequent updates
- Update map pop up boxes with more uniform look
- Update process dependent on datasets
  - Efficiency may be gained by only updating when conditions change
- IOUs in the process of upgrading and enhancing tools to accommodate improved analyses





Next Steps

Improving Methodology

- Demonstration project to enhance initial implementation from the July 1st filing
- Coordinate with research work and development being performed by software vendors
- Create integrated approach with the planning tools reducing requirements for manual data processing and conditioning
- Ensure Comprehensive Network models for each circuit
- Evaluate inclusion of Transmission, Sub-transmission, and Substation level assessment when evaluating irrespective of reverse flow through substation

Informing Other Utility Process

- Provide streamlined regularly performed process that can provide locational results to help inform interconnection Fast Track limits and/or specific thresholds in screens
- Provide DER capacity data for analysis in conjunction with DER growth to inform GRC investments where grid reinforcement is needed in high growth and low capacity areas

DRP Demo Project A

Improvement of ICA

Demonstration Project A

Purpose: provide fully dynamic time series Integration Capacity Analysis

Scope: One Distribution Planning Area evaluating all line sections and nodes

Scenarios: Perform analysis with two scenarios (1) do not allow transmission export and (2) allow transmission export

Tools and Datasets: The same tools and datasets will be used. Some improvement of the datasets will be performed such as more detailed load profiles.

High Level Tasks:

- Include more sub-criteria not initially analyzed
- Align and coordinate with software vendors and research community
- Integrate and create modules for tools to more efficiently analyze ICA
- Enhance load profiles